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MAGLAD EFFECTIVE SIMULATION, RANGE AND ALIGNMENT TOLERANCE DEMO--ETC(U)
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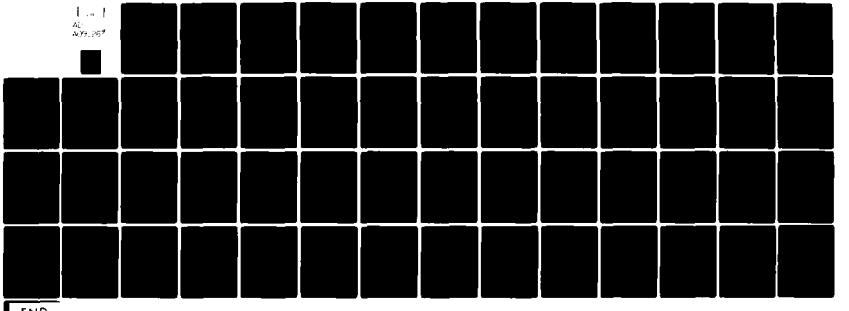

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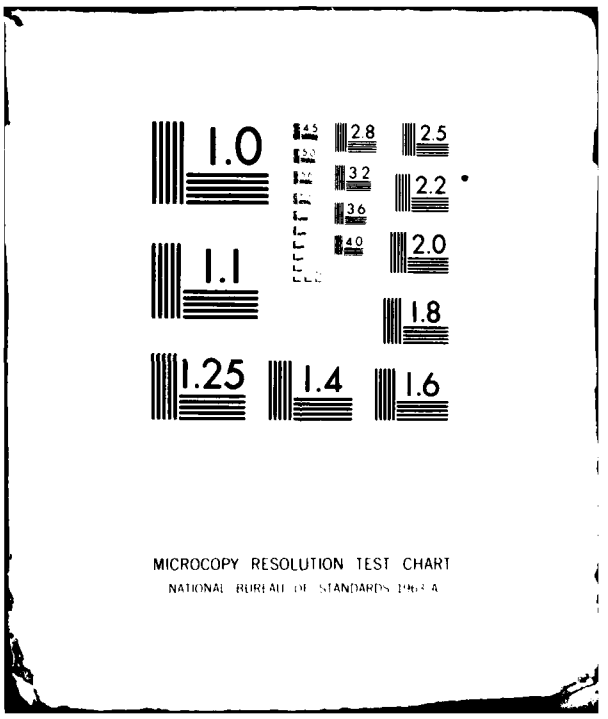
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REPORT N61339-76C-0116-2

LEVEL II

MAGLAD

EFFECTIVE SIMULATION, RANGE AND ALIGNMENT TOLERANCE DEMONSTRATION TEST PLAN (FINAL)

ATTACHMENT TO THE
TRAINER ENGINEERING REPORT

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9 February 1977

Prepared for

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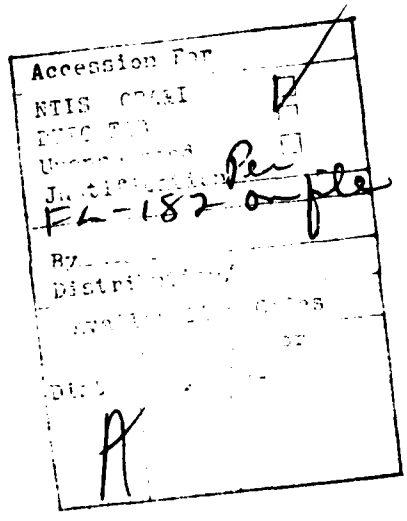
FOREWORD

This document fulfills the data requirement of CDRL Item A001 for a separate attachment to the Engineering Report containing Test Procedures and Results Report per DI-T-0001, delineating all test procedures and expected results associated with the demonstration specified in Section F for Item 0002.



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SECTION I

INTRODUCTION

1.1 GENERAL

The purpose of the Effective Simulation, Range and Alignment Tolerance Demonstration is to demonstrate:

- The system's level of discrimination between hit and miss achieved with the MAGLAD system as compared to the actual E- and F-type stationary target profiles;
- The effectiveness and accuracy of the Rifle Sight/Laser Alignment Kit;
- System invulnerability to false alarms in highest ambient light conditions;
- The full-scale system's simulation effectiveness with simulated reduced visibility via beam-power attenuation;
- The moving-target's lead angle simulation effectivnesss; and
- The 1/12 scale target's simulation effectiveness.

The Effective Simulation, Range and Alignment Demonstration, CLIN 0002, will be conducted at the contractor's facility approximately seven months after date of contract award. This demonstration will utilize breadboard models of the:

- Laser Rifle Marksmanship Trainer Device/A3F77 (CLIN 0003);
- Laser Radiation Detectors (CLIN 0003AA);
- Rifle Sight/Laser Alignment Kit (CLIN 0003AB);
- Laser Hit Indicator with Test Target Kit (CLIN 0003AC);
- Scaled Record Range Targets and Radiation Detector (CLIN 0003AD); and
- Moving-Target Rifle Laser Radiation Detector Kit (CLIN 0003AE).

All test firing, during the effective simulation demonstration, will be conducted with laser pulses only. Blank firing of the M16A1 will not be required.

1.2 TEST DATE

The dates for performance of the tests described herein will be established approximately 15 days prior to performance of the tests. The test date is tentatively scheduled for 14 February 1977.

1.3 TARGET RANGE

Target range will be measured with a Rolatape measuring wheel (Rolatape Corporation Model No. 400, 4 ft circular) which is calibrated to measure within 1/4 in. at 100 ft over smooth hard surfaces.

1.4 DEMONSTRATION OF ACCURACY OF ALIGNMENT

The problem involves mounting a statistically significant sample of transmitters on a statistically significant sample of M16A1 rifles and making a check for repeatability of alignment of transmitters with the open iron sights of the M16A1 rifles. However, only one transmitter will be available during this test phase.

The following procedure will be used:

- Mount the laser transmitter on rifle;
- Align the rifle sights with the transmitter using the Rifle Sight/Laser Alignment Kit; and
- Mount the rifle on a tripod mounted machine rest and, using the rifle sights, align the laser transmitter on a 25 m remote detector. Fire the laser to determine the alignment of the center of its beam (moving the detector across beam vertically and horizontally) with respect to rifle line of sight.

This procedure will demonstrate that the Transmitter/Alignment Kit accuracy is adequate for the purpose intended. Data from the laser pulse detection plots will determine the pulse detection centroid and give an indication of any persistent error in the alignment kit function.

It should be noted that the iron rifle sights are used for this sighting function. Thus, the alignment of the sights using the kit and the alignment of the aligned sights (and so the transmitter) with the reference point on the remote target/detector device should be done by an expert marksman.

Additional ranges of 150 m and 300 m will be evaluated following the above procedure, with the exception of sighting method. The laser transmitter will be attached to a tripod mount scope sight/laser transmitter adapter. The sighting scope crosshairs are then aligned to the transmitter beam using the rifle sight/laser alignment kit. The tripod mount sighting scope adapter will be used to aim the laser transmitter during the balance of the effective simulation demonstration.

Thus, the alignment of the sights using the kit and the alignment of the aligned sights (and so the transmitter) with the reference point on the remote target/detector device will be done by a test operator. In this way, the requirement for a statistically significant number of expert marksmen is eliminated along with the human element.

1.5 DESCRIPTION OF DEMONSTRATION

1.5.1 FULL SCALE SIMULATION EFFECTIVENESS DEMONSTRATION. Essential elements of the demonstration are shown in Figure 1. The test target consists of a target board with a visible aiming grid on which detectors can be arranged in configurations the same as they would be on E- and F-type targets in the simulation system at various ranges. The hit indicator consists of the signal processing system and power supply to indicate hits via a strobe light.

In the demonstration, the test operator -- firing from the scope sight/transmitter adapter after using the Rifle Sight/Laser Alignment Kit to align the rifle's sights -- will fire at designated coordinates on the test target. Hits will be indicated by the strobe light and recorded by the observer. From the recorded data, contours of hit/miss will be developed and compared with E- and F-type targets.

This procedure will be repeated at:

- Varied ranges from minimum to maximum with the appropriate target's detector configuration; and
- With attenuation of the laser beam power using neutral-density (ND) filters to simulate reduced visibility.

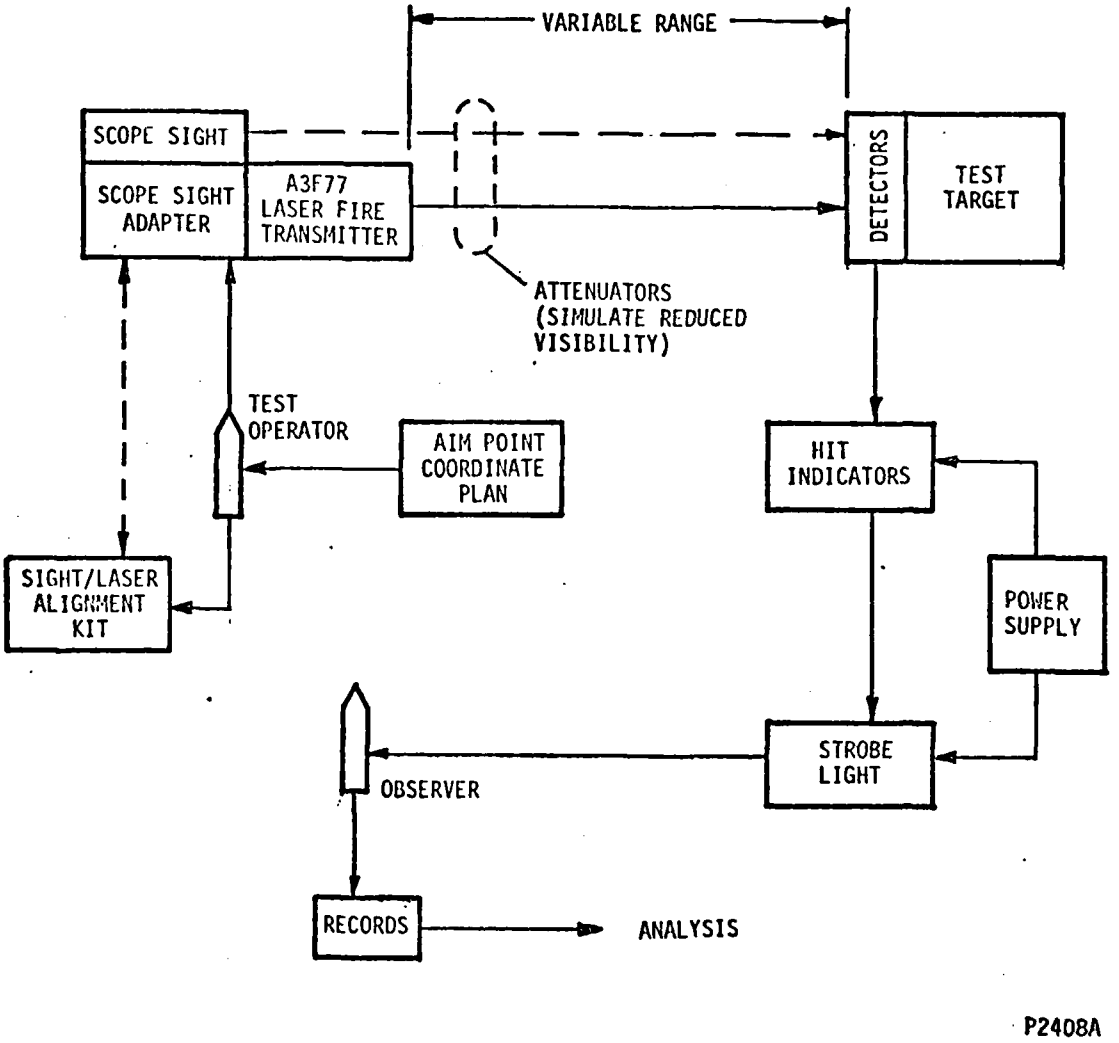


Figure 1. Block Diagram of Full Scale Simulation Demonstration

The resulting data will be used to assess the simulation effectiveness, considering the round-to-round dispersion of the M16A1.

1.5.2 MOVING-TARGET SIMULATION EFFECTIVENESS DEMONSTRATION. The Moving-Target Rifle Laser Radiation Detector Kit will utilize identical detectors to those in the Target Laser Radiation Detector Kit.

In principle, this effectiveness demonstration is very similar to the full-scale simulation effectiveness demonstration using E- and F-type targets, except that in the final system, the target -- a different, three-dimensional type -- will be moved rapidly. Because of this motion, the detector array must be advanced in front of the target's position as an approximately linear function of speed and range, in order to require the rifleman to take the proper target lead. The RETS moving-target mechanism configuration has not been defined at this date; therefore, the moving-target demonstration will prove static lead only.

Effective simulation utilizing the detectors in conjunction with the laser transmitter will have been demonstrated during the full-scale simulation effectiveness demonstration. Therefore, the Moving-Target Demonstration need only show mechanical compliance with the lead requirement specifications.

1.5.3 SCALED RANGE SIMULATION EFFECTIVENESS DEMONSTRATION. Essential elements of the demonstration are shown in Figure 2. A test target grid will be hinged on the 1/12 scale target assembly. The test target, with the appropriate silhouette, will be lowered to fire. The hit indicator is located on the target mechanism control panel.

In the demonstration, a test operator -- firing from the tripod sight adapter after using the Rifle Sight/Laser Alignment Kit to align the scope cross hairs -- will fire at designated coordinates on the test target as in the full scale demonstration. Hits will be indicated on the control panel and recorded by the observer. From the recorded data, contours of hit/miss will be developed and compared with 1/12 scale E- and F-type targets. This procedure will be repeated at various ranges from minimum to maximum with the appropriate target configuration.

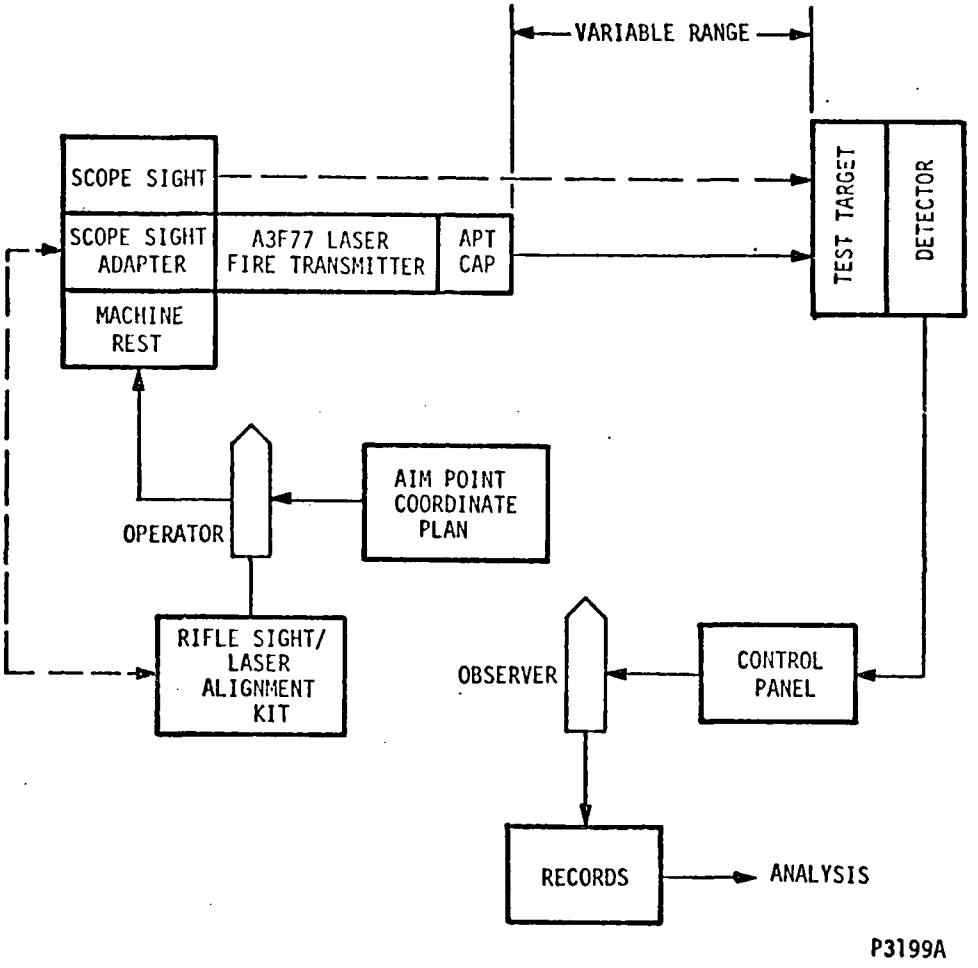


Figure 2. Block Diagram of Scale Target Simulation Demonstration

1.6 FACILITIES AND EQUIPMENT

Demonstration of all simulations will be carried out at facilities to be provided by the contractor. The government will furnish all the expert riflemen required. The government also will furnish a statistically significant, randomly selected sample of M16A1 rifles for alignment checks. The contractor will instruct the riflemen in the use of the Rifle Sight/Laser Alignment Kit and maintain, adjust and operate all contractor furnished equipment.

The contractor will furnish for the tests:

- One breadboard model of the A3F77 laser fire simulator rifle-mounted equipment (CLIN 0003);
- Two breadboard test targets;
- All breadboard detectors, mounts and harnesses (CLIN 0003AA);
- One breadboard hit indicator subsystem and power supply breadboard (CLIN 0003AC);
- One breadboard Rifle Sight/Laser Alignment Kit (CLIN 0003AB);
- One breadboard moving-target laser radiation detector (CLIN 0003AE);
- One breadboard scale target laser radiation detector (CLIN 0003AD);
- One breadboard scale target control unit (CLIN 0003AD);
- Test detector* E/W detected pulse indicator;
- One scope sight/laser transmitter adapter;
- Extension test cable for alignment kit;
- Laser transmitter remote trigger switch;
- One Velocity Program Function Generator*;
- One moving-target test target pedestal (stationary);
- Moving target lead position scale*;
- Six scale targets (CLIN 0003AD);
- One Scale Range Test Target (CLIN 0003AD);
- X-Y positioner*;
- Attenuators*, ND;

*Contractor property

- Cabling;
- All batteries* required;
- One tripod*;
- One transmitter aperture cap (CLIN 0003AD);
- One Rolatape Model 400*;
- Hit counter*;
- One rifle machine rest*;
- Two M16A1 rifles, Colt mfg (GFE);
- Shooter's pad; and
- Personnel adequate to set up and operate the equipment.

The government will furnish for the tests:

- One expert marksman;
- Four M16A1 rifles, two each of two different manufacturers other than Colt; and
- Eye safety test.

*Contractor property

SECTION II

TEST DESCRIPTIONS

2.1 DEMONSTRATION OF ACCURACY OF ALIGNMENT

2.1.1 OBJECTIVE. This procedure is to assure that the tolerances between rifle barrel reference surfaces and sight line are not excessive for the system and the transmitter/alignment kit function is adequate for the purpose intended.

2.1.2 EQUIPMENT REQUIRED. The following is a list of equipment required for this test.

- Breadboard laser transmitter (CLIN 0003);
- Rifle machine rest;
- Shooter's pad and sandbags;
- Breadboard rifle sight/alignment kit (CLIN 0003AB);
- Test radiation detector E/W indicator;
- X-Y positioner;
- Test target;
- Six M16A1 rifles (two each from three manufacturers);
- Scope sight/laser transmitter adapter;
- Tripod
- Hit counter;
- Remote trigger switch; and
- Expert marksman.

2.1.3 TEST SETUP. This test will be performed using the configuration shown in Figure 3.

2.1.4 TEST DURATION. The estimated time required for this test element is one day.

2.1.5 DATA REQUIRED. The following data will be required throughout all firings conducted during this test element:

- Range to target;
- Location of aim point;
- Location of test radiation detector;

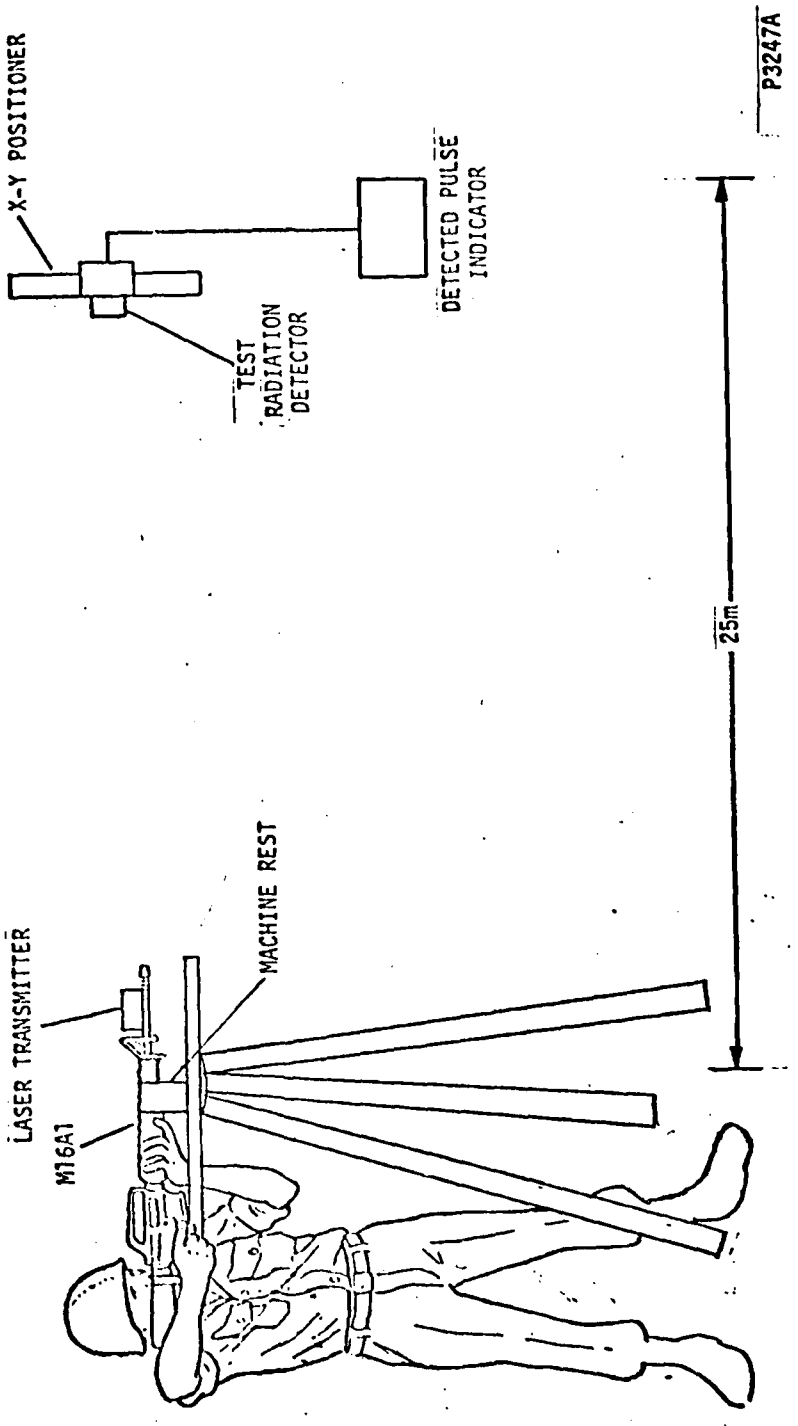


Figure 3. Block Diagram of Alignment Accuracy Demonstration

- End point locations of test radiation detector;
- Time required to mount transmitter to rifle;
- Time required to align iron sights; and
- Range of clicks left on sights after alignment.

2.1.6 TEST PROCEDURE

2.1.6.1 Test Detector Positioning. Set up the X-Y positioner mounted test detector on a tripod at 25 m range. An indicator connected to the test detector will light each time a laser pulse is detected and is timed to light continuously while receiving laser pulses at the alignment mode rate. Rifle iron sight alignment and aiming is to be conducted by an expert rifleman.

2.1.6.2 Sight Alignment. Mount the laser transmitter on the M16A1 rifle and align the sights with the transmitter using the rifle sight/laser alignment breadboard kit.

The laser transmitter will be fired during this test in a repetitive pulse mode utilizing an external battery supply. A test extension cable is used to connect the laser transmitter to the sight alignment kit for external battery operation. The repetitive pulse mode is obtained by operating the laser in the alignment mode.

2.1.6.3 Laser Transmitter Alignment. Mount the rifle on a machine rest and using the rifle sights, align the laser transmitter on the test detector. Trigger the laser and, after recording the detector location, translate the detector in one axis using the X-Y positioner until the detected pulse indicator is extinguished then record the new position. Scan the detector in the opposite direction until the indicator relights and is again extinguished and record the reading. Return the test detector to the starting position and repeat the measurements in the other axis. This procedure will establish the laser beam centroid which is then compared to the rifle sight aim point. Return the test detector to the starting position and verify rifle sight aim point. The beam centroid should be displaced downward from the aim point by 1-3/8 in. due to sight/transmitter parallax. Replicate the above test for each of the six M16A1 rifles.

Additional alignment demonstrations will be conducted by the test operator at 150 and 300 m utilizing the scope sight/laser transmitter and adapter instead of iron sights for aiming. The sighting scope cross hairs will be aligned to the laser beam using the rifle sight/alignment kit in the same fashion as the rifle iron sights.

Remove the laser transmitter from the M16A1 rifle and mount on the scope sight/laser transmitter adapter. Align the scope cross hairs with the transmitter beam using the rifle sight/laser alignment breadboard kit.

CAUTION

Place an IR absorbing filter such as KG-3 over the sighting scope aperture while viewing the image in the alignment kit.

From a tripod mount, using the sighting scope, align the laser transmitter on the test radiation detector located at 150 m range on a test target board. Place the transmitter in the alignment mode and connect to an external battery supply, trigger the laser and record location. Translate the transmitter aim point in one axis and determine beam edges. Repeat the scan in the second axis again determining beam edges. Continue this procedure until the laser beam centroid has been established. Replicate the above procedure at 300 m range. Data will be combined to provide best estimate of alignment tolerance.

2.1.7 ACCEPTANCE CRITERIA. The breadboard laser transmitter must demonstrate interchangeability among like, Colt manufactured, weapons which will allow the weapon line of sight to be adjusted, parallel to the laser, within the weapon sight tolerance. Transmitter mounting and weapon sight alignment with the laser beam should be accomplished within the following time limits:

- Mounting time -- 10 min
- Alignment or zeroing time -- 10 min

The rifle sight/alignment kit must demonstrate capability for aligning the sight pattern to the laser beam within the limits of Table 1.

2.1.8 TEST RECORDING. Data for this test will be recorded on the test record form shown in Figure 4. Aim points will be plotted on the chart shown in Figure 5.

TYPE TEST ALIGNMENT TOLERANCE TEST #_____

TARGET RANGE_____ TYPE_____ DATE_____

TEMPERATURE_____ HUMIDITY_____ TIME_____

TRANSMITTER S/N_____ DETECTOR S/N_____

RIFLE S/N_____ MFG._____

SCOPE SIGHT/LASER TRANSMITTER ADAPTER_____

MARKSMAN_____ TEST OPERATOR_____

ATMOSPHERIC CONDITIONS/EST VISIBILITY_____

TRANSMITTER MOUNTING TIME_____ ALIGNMENT TIME(IRON SIGHTS)_____

SIGHT SETTING, RANGE OF CLICKS LEFT AFTER ALIGNMENT:

WINDAGE_____ ELEVATION_____

#	TEST DETECTOR X-Y POSITION						
	START	ENDPOINT				CENTROID	
	REFERENCE	LEFT	RIGHT	UP	DOWN	LEFT/RIGHT	UP/DOWN
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
AVERAGE							

Figure 4. Test Form

TEST CONDUCTED BY: _____

TEST WITNESSED BY: _____

APPROVAL BY: _____

DATE: _____

Figure 4. Test Form (cont'd)

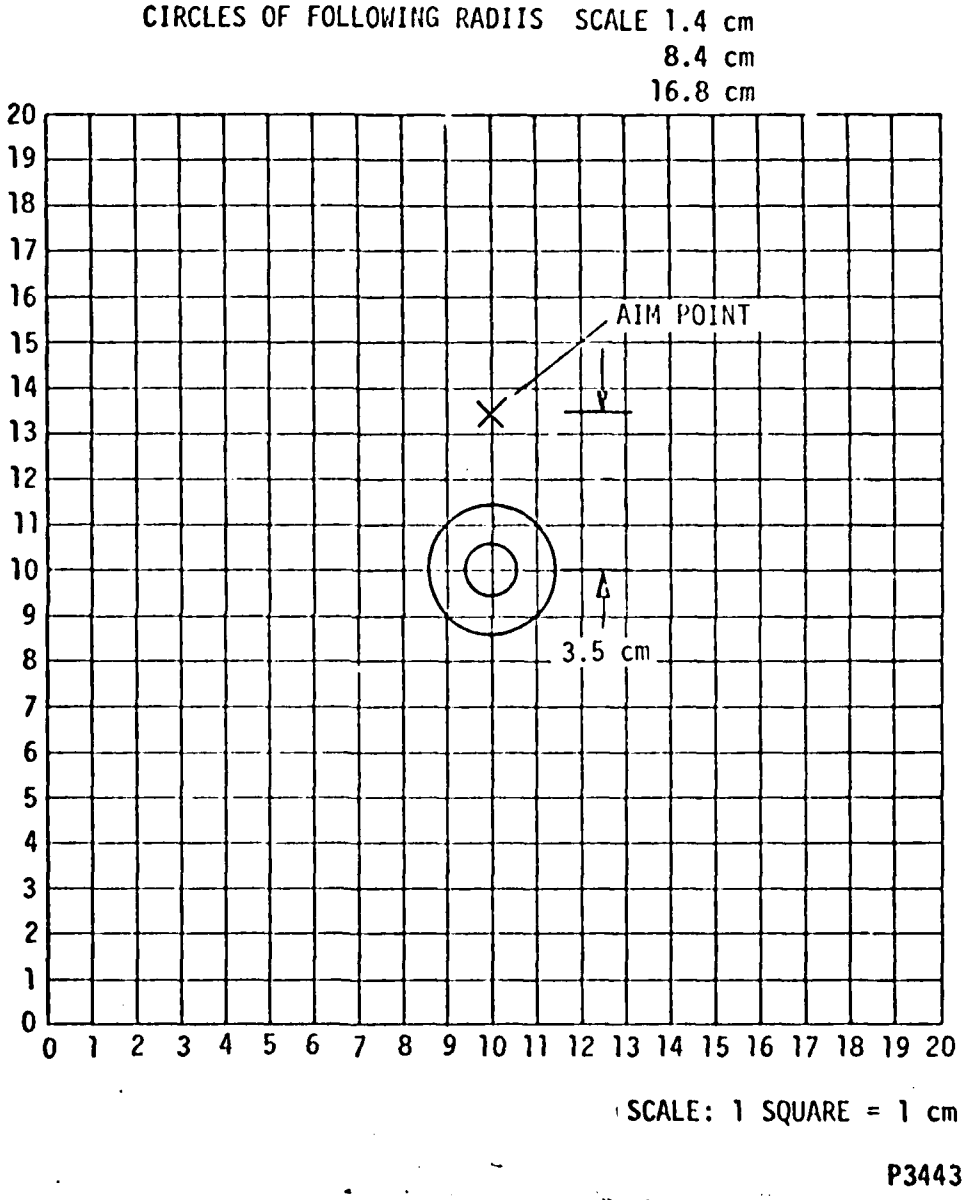


Figure 5. Test Record Chart

Table 1. Laser Beam Centroid
(Displacement From Aim Point)

Range (m)	Individual Error (cm)	RMS Error (cm)
25	1.4	0.7
150	8.4	4.2
300	16.8	8.4

2.1.9 TOLERANCE DATA. The rifle sight/alignment kit provides capability for aligning the sight pattern to the laser beam within the following variances:

	Click Stops	25 m Displacement
Individual Sight Alignment	2	1.4 cm
3-Sight Alignment RMS Average	1	0.7 cm

This value is well within the 3 cm diameter circle "A" of the M16A1 rifle shot group template used for satisfactory 3-round shot groups fired from the prone supported or foxhole position at 25 m (FM 23-9).

2.2 EFFECTIVE SIMULATION OF FIRING WITH SERVICE AMMUNITION AT MINIMUM, MAXIMUM AND INTERMEDIATE RANGES

2.2.1 OBJECTIVE. The following paragraphs describe the objectives of this test.

Objective A. These tests will utilize special testing targets with a matrix of aiming points provided both inside and outside of a superimposed target shape (with laser radiation detector mounted). Matrix aiming points will be where vertical and horizontal lines cross and will be close enough together to establish "hit" and "miss" areas within the required tolerance when the aiming points are "fired" upon successively by a test operator utilizing the tripod mounted laser transmitter. "Hit" or "miss" will be sensed by observing a flash hit indicator at

the target and reading "hits" recorded on a "hit" counter. The results of each "shot" will be recorded on prepared tables or charts, and the "hit" and "miss" areas plotted on scale targets for submission with the test report. This test will be conducted for each type target specified at the minimum and maximum specified ranges and at the following intermediate ranges: Every 25 m from 25 to 100 m for the F targets and every 50 m from 150 to 300 m for the E targets.

Objective B. Detection at maximum range and limits of detection under condition of reduced visibility are as follows:

- Visibility reduced to 150 m for targets located at ranges from 25 to 150 m; and
- Whenever the target is visible to the rifleman for targets located at ranges beyond 150 m.

The test described in "Objective A" will be duplicated using attenuators (ND) filters in the transmitter to simulate the reduction in laser power at the target due to reduced visibility.

2.2.2 TEST EQUIPMENT REQUIRED. The following is a list of equipment required for this test.

- Laser transmitter (Breadboard CLIN 0003);
- Test targets (F & E);
- Laser Radiation, Detectors (Breadboard CLIN 0003AA);
- Hit Indicator (Breadboard CLIN 0003AC);
- Battery supply, Hit Indicator;
- Hit counter;
- Scope Sight/Laser Transmitter Adapter;
- Tripod;
- Tables/Charts;
- Alignment Kit (Breadboard CLIN 0003AB); and
- ND filters and holder.

2.2.3 TEST SET-UP. This test will be performed using the configuration shown in Figure 6.

2.2.4 TEST DURATION. The estimated time required for this test is two days.

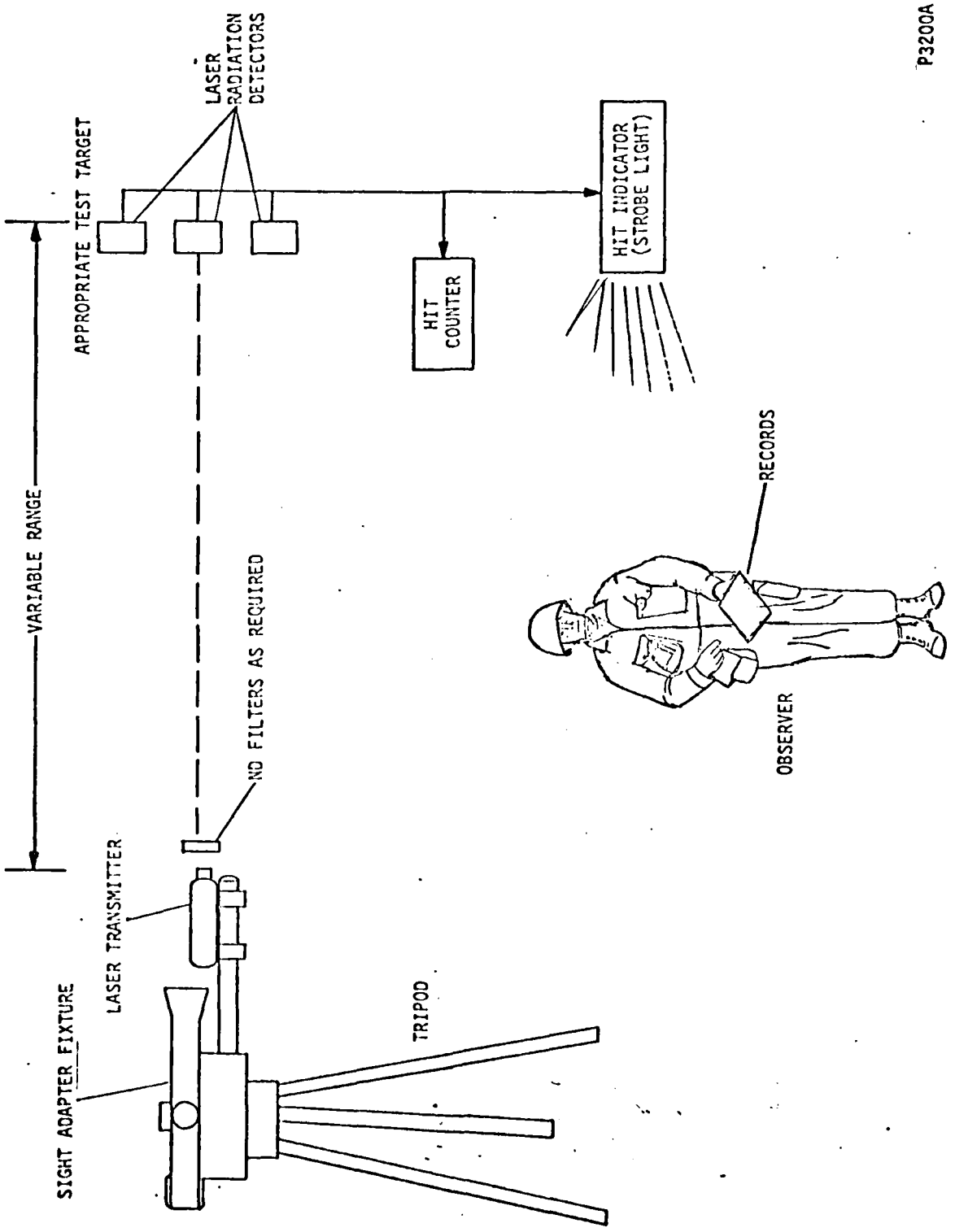


Figure 6. Test Configuration, Simulation of Firing with Service Ammunition

2.2.5 DATA REQUIRED. The following data will be required throughout all firings conducted during this test element:

- Range to target;
- Target configuration;
- Location of aim point;
- Number of shots fired;
- Number of recorded target hits;
- Number of false hits recorded;
- Number of proper system responses;
- Number of failures of system to respond properly;
- Value of ND filter utilized to simulate a given visibility reduction; and
- Visibility simulated.

2.2.6 TEST PROCEDURE

2.2.6.1 Simulation of Firing With Service Ammunition at Minimum, Maximum and Intermediate Ranges. The test targets for full scale "E" and "F"-type targets will be supported by a stand. The targets will be painted white with a gridwork of black lines vertically and horizontally oriented and a black line outline of the appropriate target shape to be tested. The appropriate laser radiation detectors to be used with the target shape on the test target will be mounted in their proper position within the perimeter of the silhouette target (Figure 7). The grid spacing on each of eight test target ranges to be tested will have primary grid lines of 6 cm spacing and secondary grid lines of 2 cm spacing to provide aiming points which will allow establishment of effective simulation within a tolerance appropriate to the range and to the parameters of the weapons simulator.

A "hit" registered by the test target will be indicated by one flash of the hit indicator strobe light and counted on the "hit" counter located near the test target. The strobe light will be visible at the firing line at up to a 300-m range with the use of optical devices in bright sunlight. For ranges between 25 and 100 m, the laser detector arrays used will be compatible with an F-type silhouette target; for ranges between 150 and 300 meters, the detector arrays will be compatible with an E-type silhouette target.

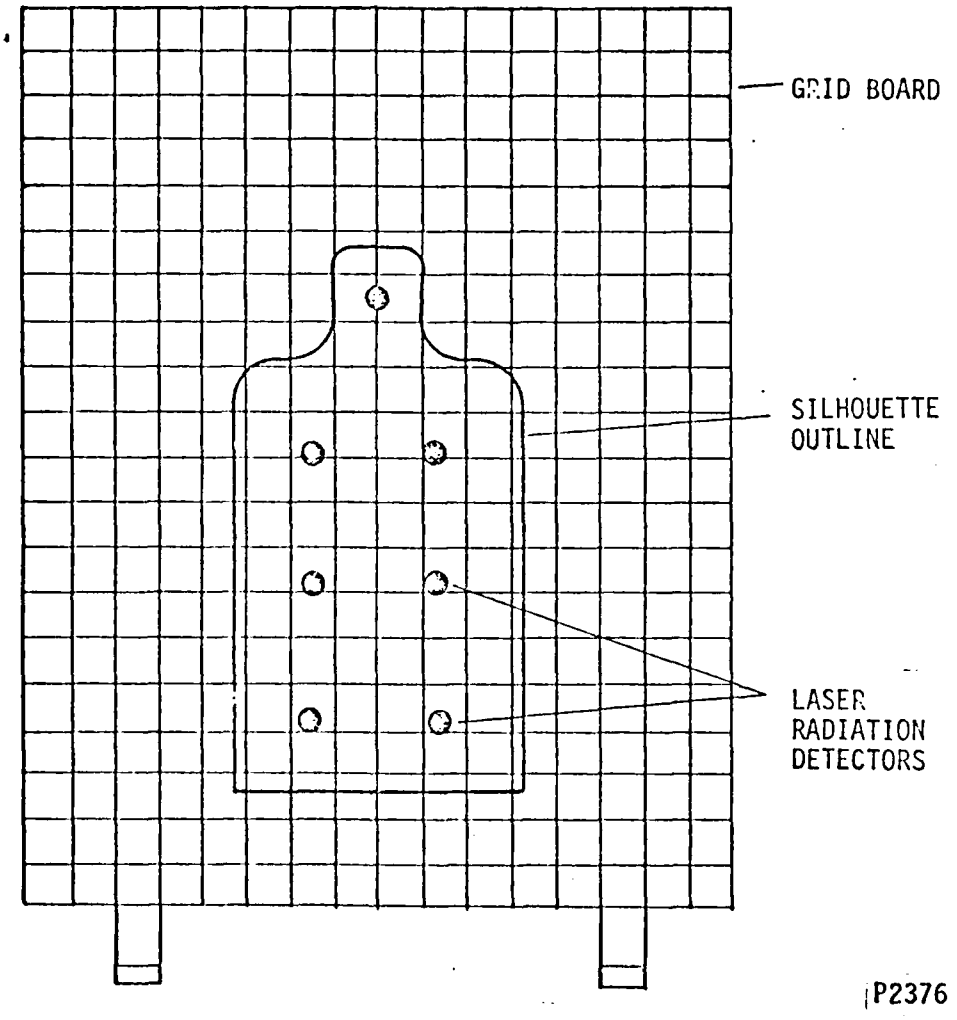


Figure 7. Full Scale Test Target for E- and F-Type Silhouettes

A set of aiming points will be selected on the test target. These points will lie outside the silhouette target such that laser pulses aimed at these points should not trigger the Hit Indicator. In addition to these aiming points, a second set of aiming points are within the target silhouette such that laser pulses aimed at these points should trigger the Hit Indicator.

Firing will be conducted from a tripod mounted scope sight/transmitter adapter by test operators. A portion of the firing may be conducted by an expert marksman firing from a supported position at the discretion of the government.

At each of the ranges indicated in Table 2, 20 round firings will be conducted using each of the aiming points of the group as indicated.

Table 2. Target Type

Target Range (m)	Target Type
300	E
250	E
200	E
150	E
100	F
75	F
50	F
25	F

Upon completion of the testing, the ratio of proper responses to improper responses will be calculated for each range of fire at each aim point considered. The relationship between percent correct response, range, and percent incorrect response will be determined. Data will be combined to provide best estimates of effective simulation.

2.2.6.2 Detection Range Versus Visibility. The test procedure will be essentially as described in paragraph 2.2.6.1. Additionally, an appropriate value of attenuation (ND filters) will be placed in front of the laser transmitter to simulate a reduction in visibility. Data collected will be combined to provide best estimates of effective simulation.

At a range of 300 m, the laser beam undergoes a total atmospheric attenuation of 8 dB, with a proportionately lower attenuation at shorter ranges in accordance with the relation: attenuation = 8 x R/300 dB, where R is the target range in meters.

At each of the ranges indicated in Table 3, 20 round firings will be conducted using each of the selected aiming points with the indicated value of attenuation in front of the transmitter beam.

Table 3. Attenuator Value

Target Range (m)	Target Type	Attenuation (dB)	ND Filter Value #
300	E	8.00	0.80 ± 0.1
250	E	6.66	0.67 ± 0.1
200	E	5.33	0.53 ± 0.1
150	E	4.00	0.40 ± 0.1
100	F	2.66	0.26 ± 0.1
75	F	2.00	0.20 ± 0.1
50	F	1.33	0.13 ± 0.1
20	F	0.53	-

2.2.7 ACCEPTANCE CRITERIA. In the Trainer Engineering Report (Preliminary) for MAGLAD/A3F77, Data Item A001AA, it was concluded that for the purpose of demonstrating effective simulation, test aim points should be selected inside and outside of the true target edge at each range based on an angular deviation delta of 0.4 mr 1 σ, at ranges 150 m and out or at a linear achievable delta for 25 to 100 m based on measured data.

Based on these criteria ILS has selected best aim points for the simulation demonstration and these are given in Table 4 with a comparison of probabilities of correct scoring by both MAGLAD and the M16A1.

Inside and outside aim point borders are represented on the F and E target test record chart. The acceptable hits or misses is equal to 99% of the total rounds fired at each target range.

Table 4. Selected Aim Points

Range F&E (m)	Delta (0.4 mr 1σ) (cm)	(in)	MAGLAD Aim Points Normal to Edge (cm)	(in)	Correcting Indicating Hit or Miss Probability (MAGLAD)	(M16A1)
25	1	0.4	± 5.0	1.96	99%	> 99%
50	2	0.79	± 5.0	1.96	99%	> 99%
75	3	1.2	± 5.0	1.96	99%	98%
100	4	1.6	± 5.0	1.96	99%	89.4%
150	6	2.4	± 6.0	2.4	99%	84%
200	8	3.1	± 8.0	3.1	99%	84%
250	10	3.9	±10.0	3.9	99%	84%
300	12	4.7	±12.0	4.7	99%	84%

For example, if 10 aim points were selected inside the silhouette such as to be within the acceptance border for all hits, then a total of 10 aim points x 20 rounds = 200 total rounds fired. Total misses allowed would be: 200 rounds total fired less (0.99 x 200) 198 hits required resulting in two allowable misses.

2.2.8 TEST RECORDING. Test data will be recorded on the test form shown in Figure 8. Aim points will be charted on the chart form illustrated in Figures 9 and 10.

2.2.9 TOLERANCE DATA. The objective is to demonstrate scoring accuracy consistent with the round-to-round dispersion of 0.4 mils, 1 σ, obtained with service ammunition using targets and ranges specified (3.2.1 of N2234-129A). The target hit probability for this dispersion is shown in Figure 11 as a function of aim point. Figure 11 assumes the E-type target.

2.3 OPERATION UNDER AMBIENT LIGHT CONDITIONS

2.3.1 OBJECTIVE. The following describes the objectives of this test.

Objective A. Demonstration of range performance in varying ambient light conditions.

Objective B. Demonstration of system's invulnerability to ambient light induced false alarms.

TYPE TEST _____ TEST # _____

TARGET RANGE _____ TYPE _____ DATE _____

TEMPERATURE S/N _____ DETECTOR S/N _____

RIFLE S/N _____ MFG. _____

SCOPE SIGHT/LASER TRANSMITTER ADAPTER _____

MARKSMAN _____ TEST OPERATOR _____

ATMOSPHERIC CONDITIONS/EST VISIBILITY _____

TRANSMITTER MOUNTING TIME _____ ALIGNMENT TIME(IRON SIGHTS) _____

SIGHT SETTING, RANGE OF CLOCKS LEFT AFTER ALIGNMENT:

WINDAGE _____ ELEVATION _____

SIMULATED VISIBILITY RANGE _____

ATTENUATOR (ND) FILTERS USED _____

LOCATION COORDINATE OF AM POINT (PLOT ON REVERSE SIDE) _____ _____

AIM POINT FOR HITS _____ OR MISSES _____

	20 ROUND GROUP SHOT #	HITS	MISS	PROPER RESPONSE	IMPROPER RESPONSE	NATURE OF FAILURE
	1					
	2					
	3					
	4					
	5					
	6					
	7					
	8					
	9					
	10					
TOTAL						

TOTAL ROUNDS FIRED = 20 X TOTAL NO. SHOTS = _____

ACCEPTABLE HIT/MISS = 0.99 X TOTAL ROUNDS FIRED = _____

Figure 8. Test Form

TEST RESULTS

ACCEPTABLE_____
NOT ACCEPTABLE_____

TEST CONDUCTED BY:_____

TEST WITNESSED BY:_____

APPROVAL BY:_____

DATE:_____

Figure 8. Test Form (cont'd)

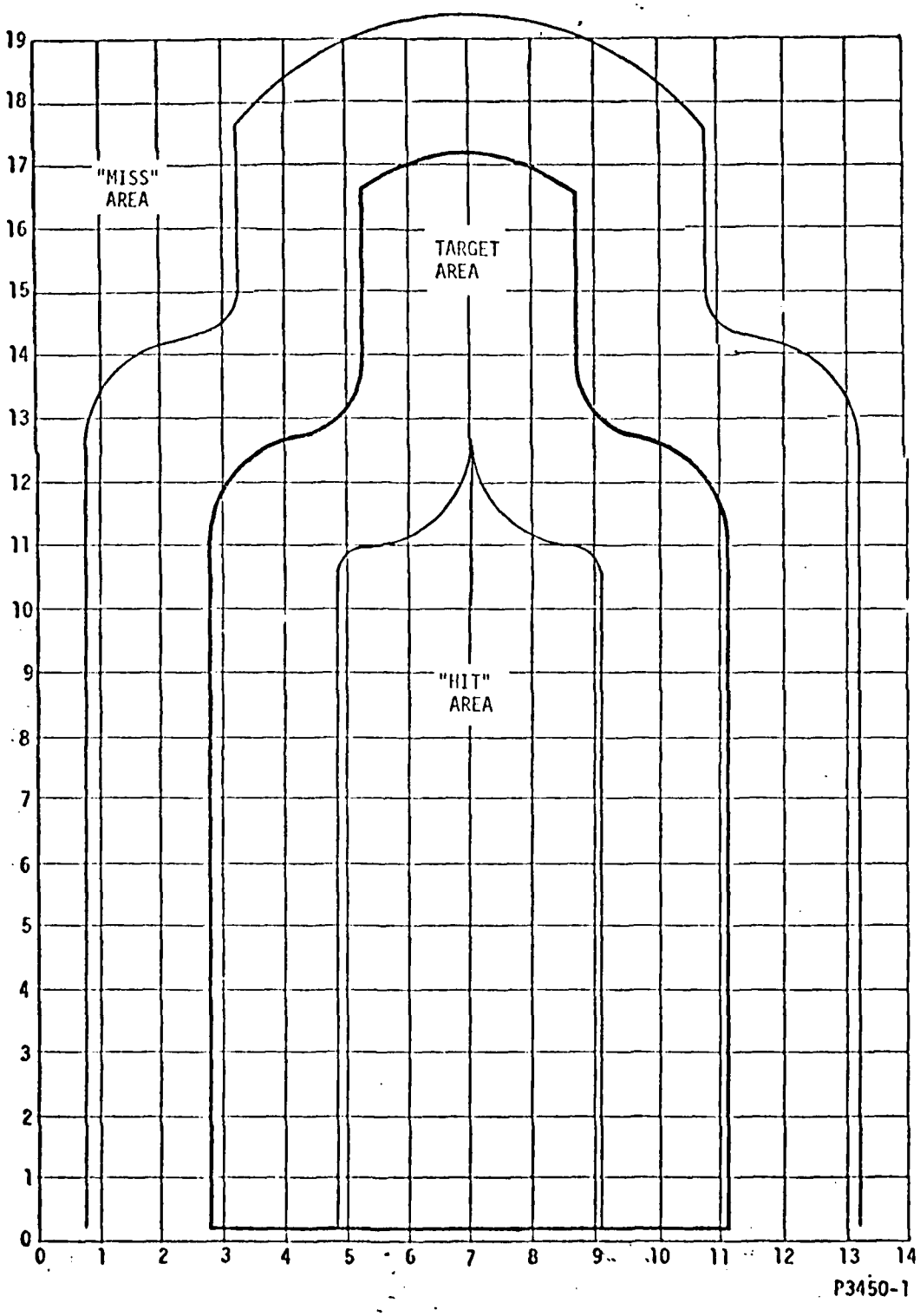


Figure 9. E-Target Test Record Chart, 300 m (Sheet 1 of 4)

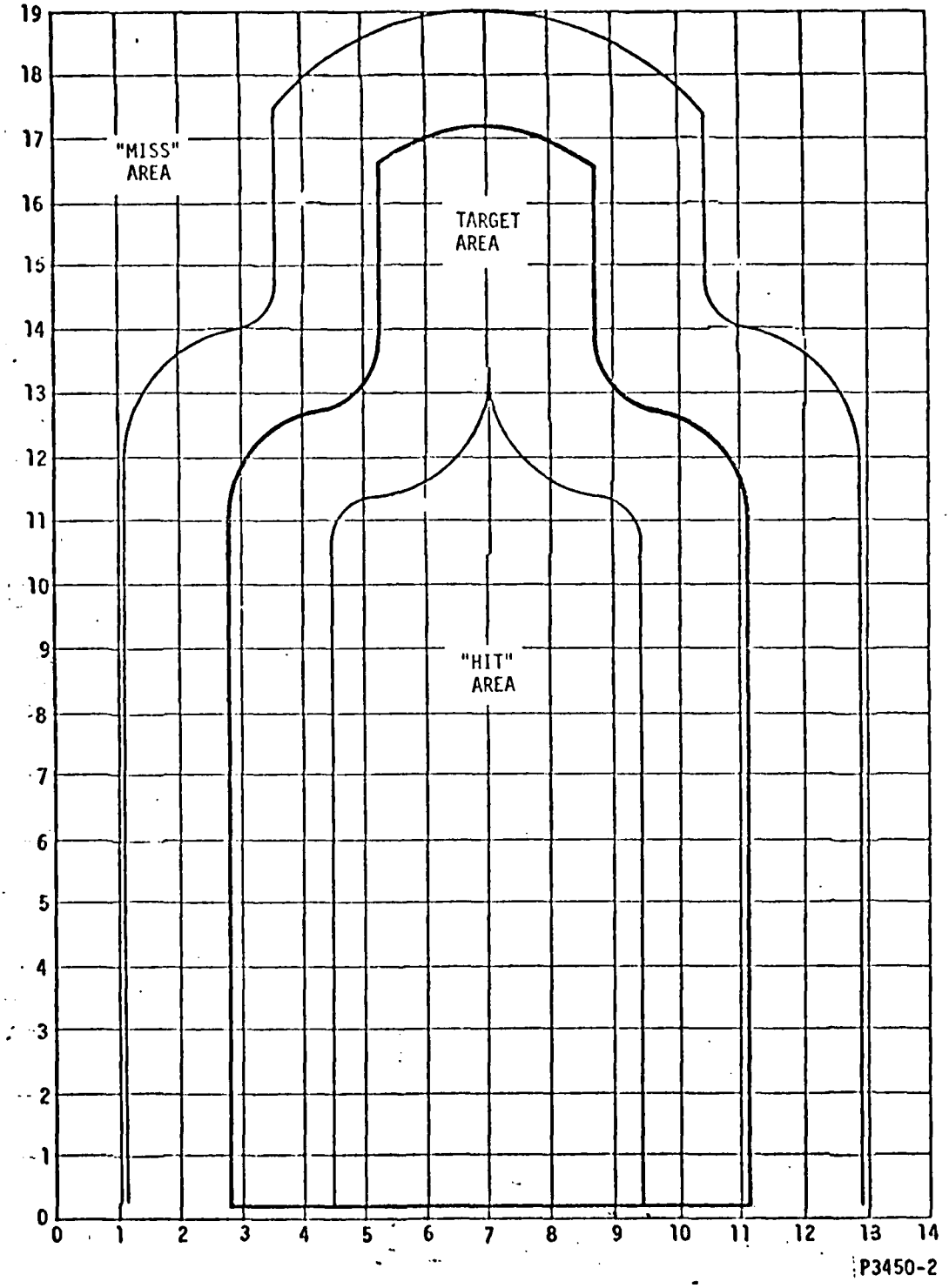


Figure 9. E-Target Test Record Chart, 250 m (Sheet 2 of 4)

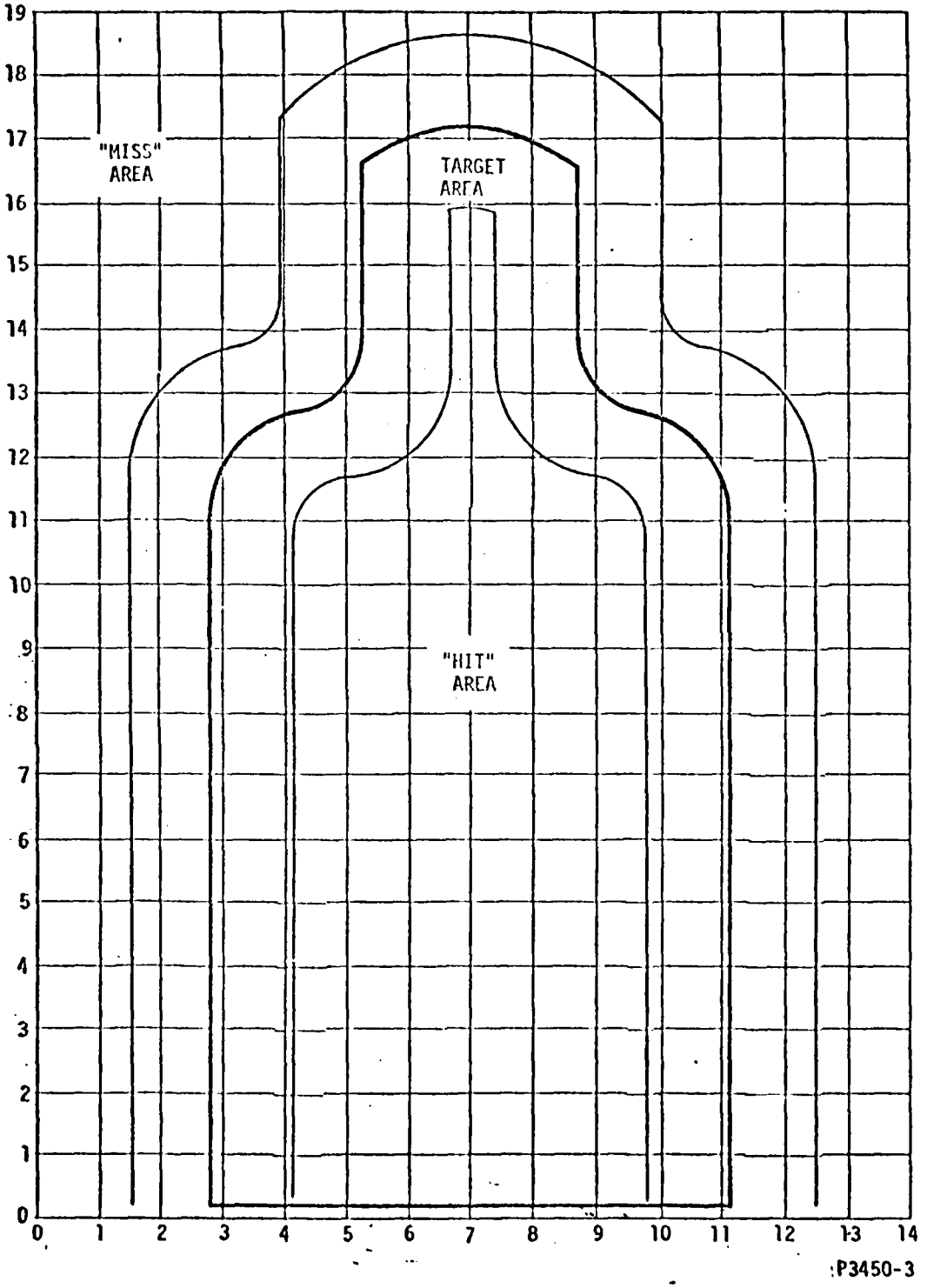


Figure 9. E-Target Test Record Chart, 200 m (Sheet 3 of 4)

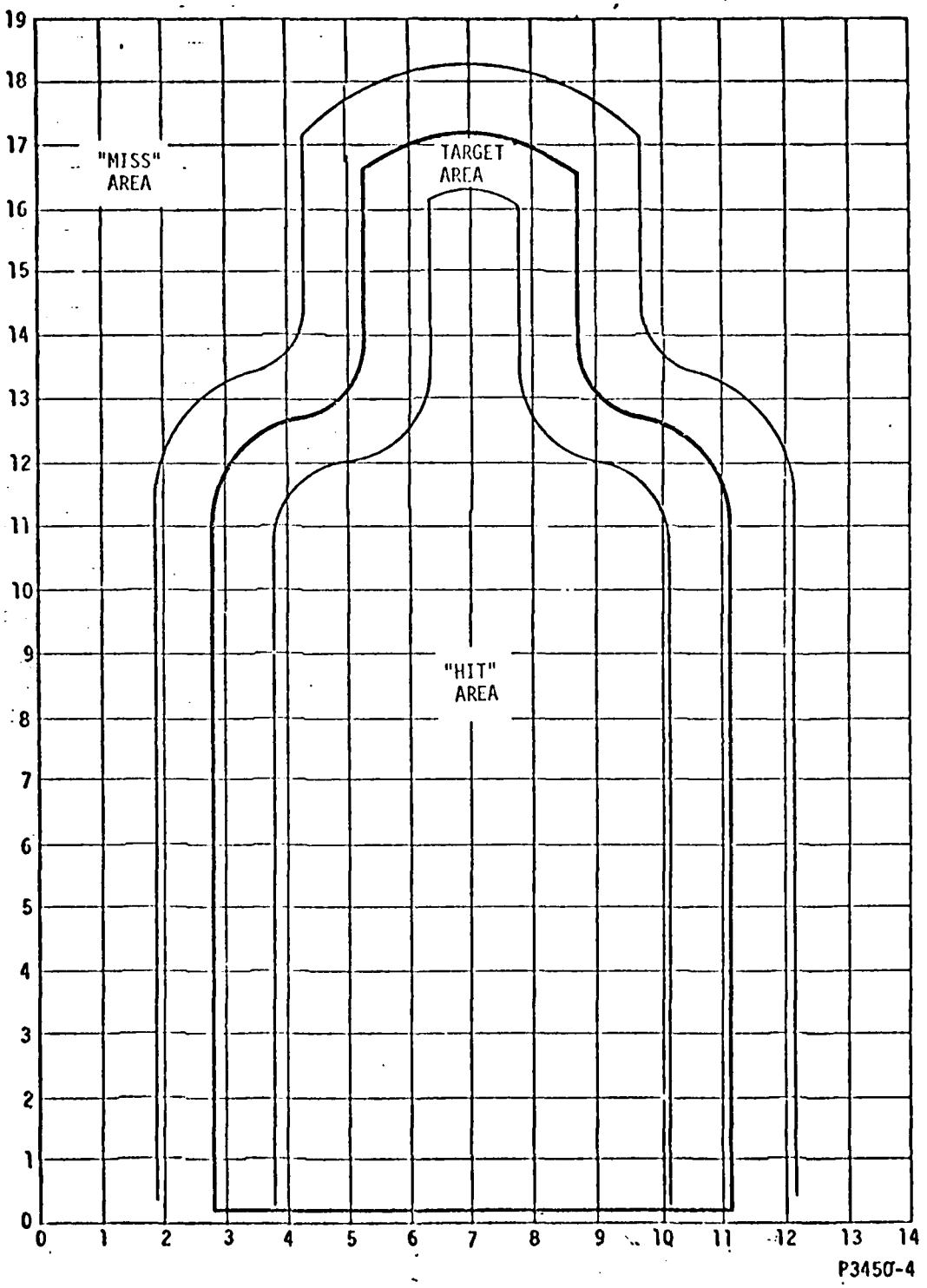


Figure 9. E-Target Test Record Chart, 150 m (Sheet 4 of 4)

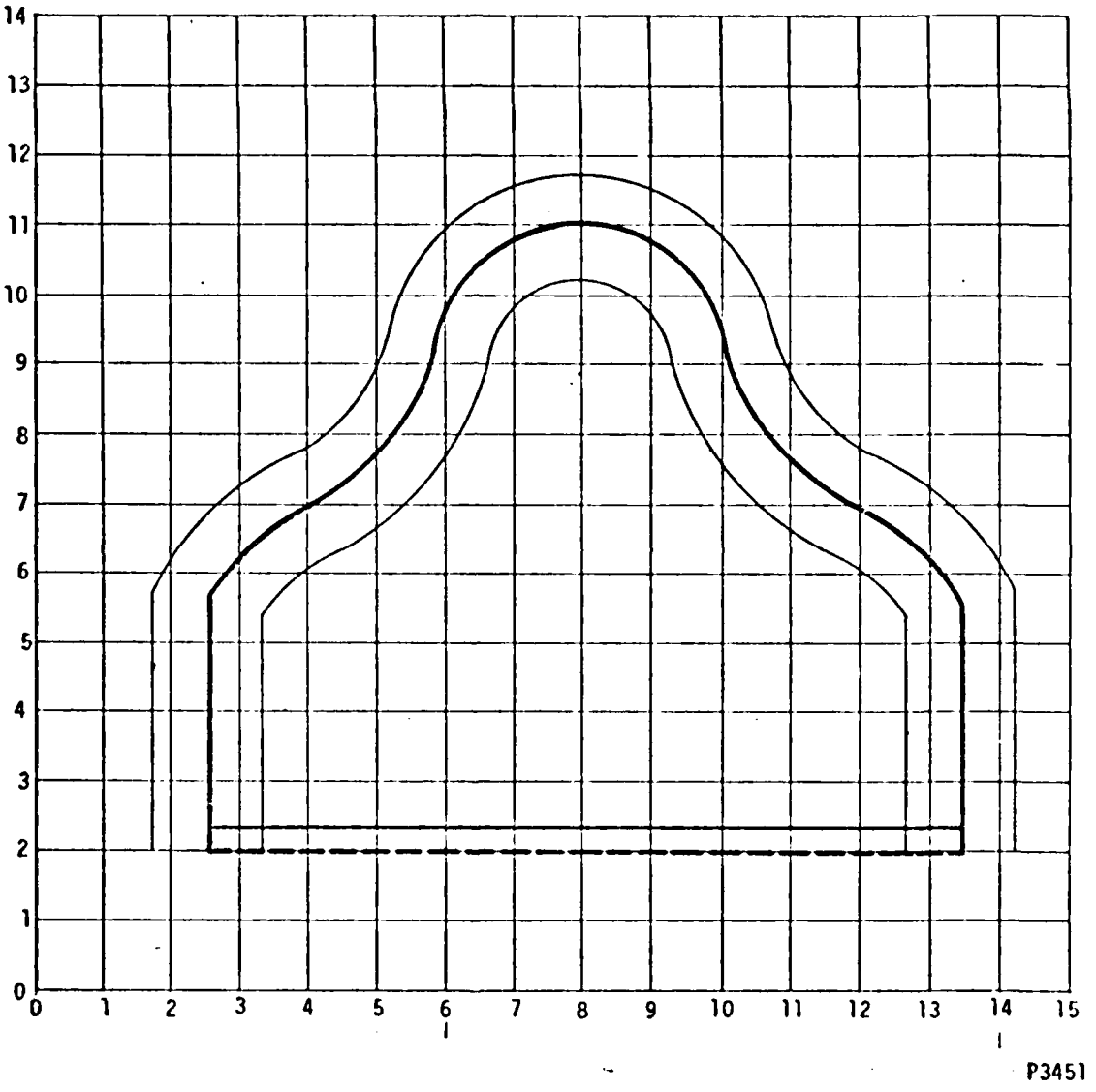


Figure 10. F-Target Test Record Chart

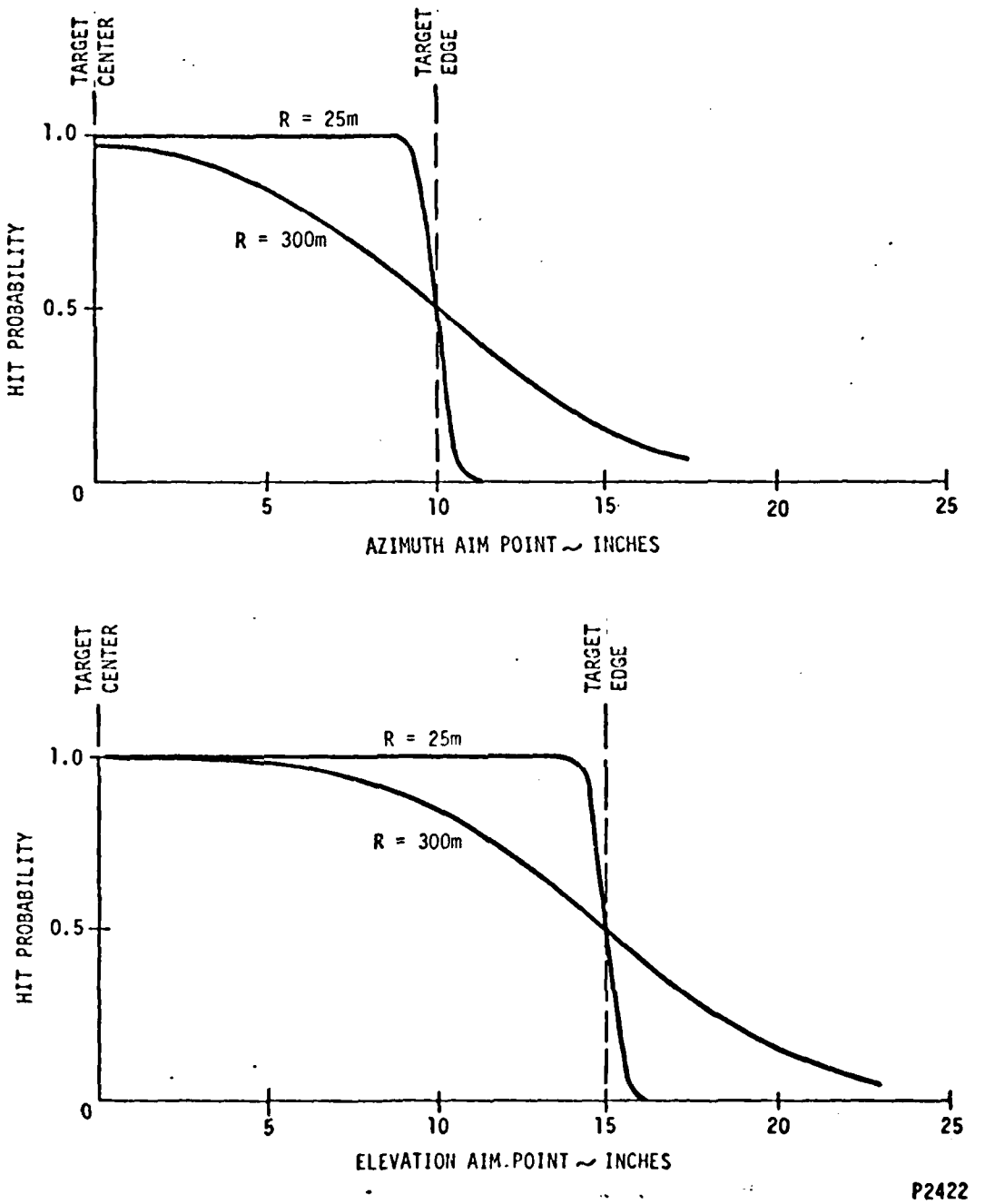


Figure 11. E-Target Hit Probability for the 0.4 mr, 1 σ, Weapon Dispersion

2.3.2 TEST EQUIPMENT REQUIRED. The following is a list of test equipment required for this test.

- Test target;
- Laser Radiation Detectors (Breadboard CLIN 0003AA);
- Hit Indicator (Breadboard CLIN 0003AC);
- Battery supply, hit indicator; and
- Hit counter.

2.3.3 TEST SET-UP. This test will be performed using the test configuration shown in Figure 6 for Objective A. Test target and hit counter only will be required for Objective B.

2.3.4 TEST DURATION. The estimated time required for this test is one day.

2.3.5 DATA REQUIRED. Data obtained in paragraph 2.2 will provide requirements for the test element of Objective A.

Data required for Objective B is the total number of false hits recorded for this test element.

2.3.6 TEST PROCEDURE

2.3.6.1 System Operation Under Varying Ambient Light Conditions. The system's ability to operate under varying ambient light conditions will effectively be demonstrated during the Effective Simulation of Firing with Service Ammunition Demonstration (paragraph 2.2).

2.3.6.2 System Invulnerability to Ambient Light Induced False Alarms. The system's invulnerability to ambient light induced false alarms will effectively be demonstrated by operation of the system in full sunlight. The test target, with detectors mounted and hit counter connected, will be placed outdoors on a full sunlit day. Any ambient light induced false alarms will be recorded on the hit counter.

2.3.7 ACCEPTANCE CRITERIA. The breadboard models of the laser transmitter, laser radiation detector and hit indicator should demonstrate an absence of false hits recorded.

2.3.8 TEST RECORDING. Data for test element A will be recorded during tests 2.1 and 2.2 of this test plan. Data for test element B will be recorded on the test form Figure 12.

2.3.9 TOLERANCE DATA. The MAGLAD system is designed to prevent false hit detection.

2.4 MOVING TARGET LEAD ANGLE SIMULATION DEMONSTRATION, STATIC

2.4.1 OBJECTIVE. To statically demonstrate that proper lead angle is achieved by applying a voltage representating the RETS tachometer output to the lead angle servo system, and observing the displacement of the detector array. Tests shall be conducted at the minimum and maximum simulated ranges of 25 to 200 m and specified intermediate ranges (3.2.1 & 4.4.2.2.2 of N2234-129A). A simulated moving RETS target is not required as part of the Effective Simulation Test (Section F, C-6 of contract).

2.4.2 TEST EQUIPMENT REQUIRED. The following is a list of equipment required for this test.

- Moving-target lead servo mechanism with detector mounting frame (Breadboard CLIN 0003AE);
- Target support pedestal;
- Velocity program function generator;
- One meter measuring scale; and
- Test record form.

2.4.3 TEST SET-UP. This test will be performed using the configuration shown in Figure 13.

2.4.4 TEST DURATION. The estimated time required for this test is one day.

2.4.5 DATA REQUIRED. The following data will be required throughout this test element:

- Range simulated;
- Target speed simulated;
- Detector lead position;
- Number of proper system responses; and
- Number of failures of system to respond properly.

TYPE TEST _____ TEST # _____

TARGET RANGE _____ TYPE _____ DATE _____

TEMPERATURE _____ HUMIDITY _____ TIME _____

DETECTOR S/N _____ TEST OPERATOR _____

ATMOSPHERIC CONDITIONS/EST VISIBILITY _____

	NO.	START TIME	END TIME	DURATION	# FALSE HITS
Total					

TEST RESULTS

ACCEPTABLE _____
NOT ACCEPTABLE _____

TEST CONDUCTED BY: _____

TEST WITNESSED BY: _____

APPROVAL BY: _____

DATE: _____

Figure 12. Test Form

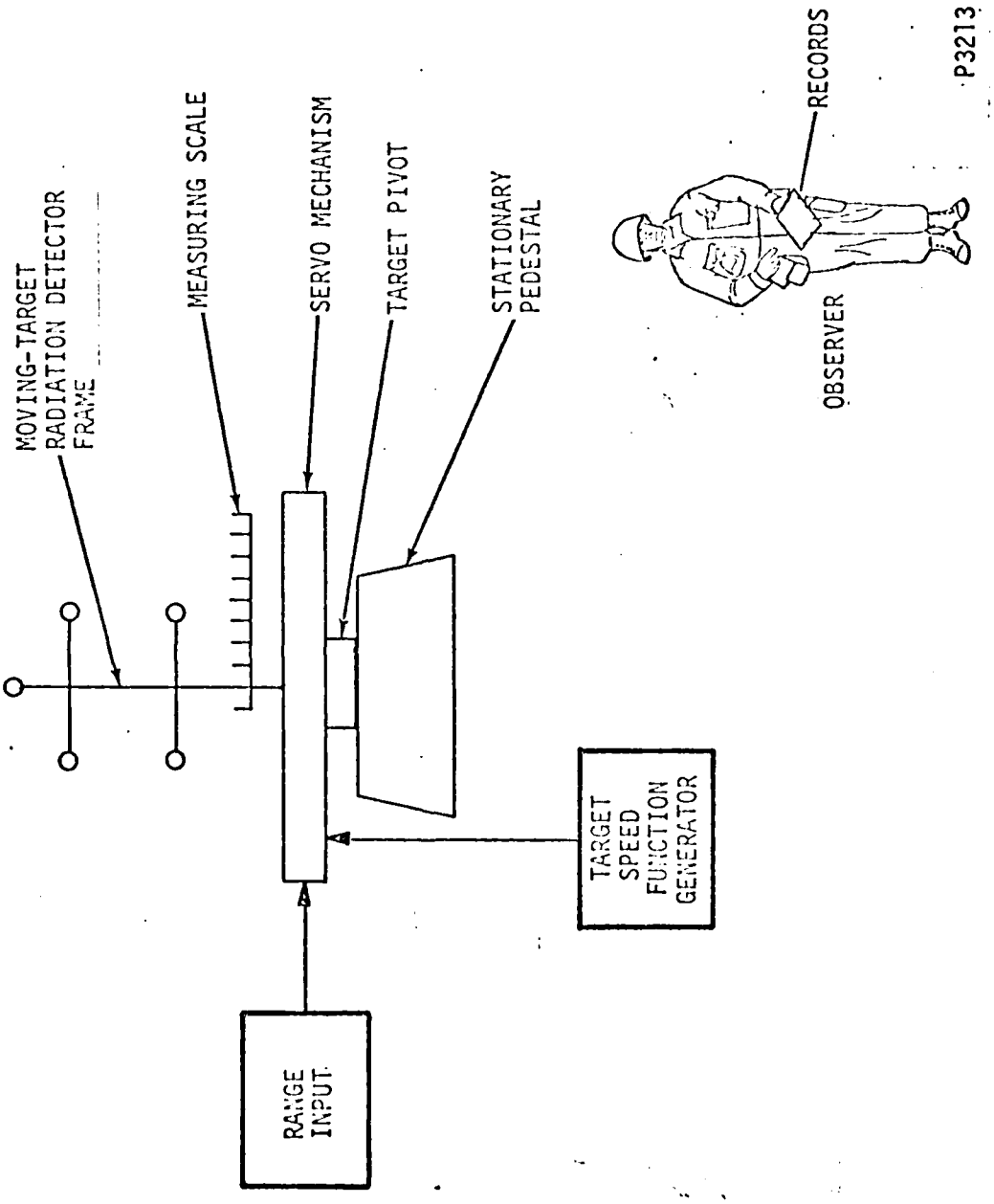


Figure 13. Test Configuration, Moving Target

2.4.6 TEST PROCEDURE

2.4.6.1 Target Pop-Up and Fall. The lead angle servo mechanism and detector support frame will be attached to the stationary test pedestal with a pivot arrangement so as to demonstrate target pop-up and fall compatibility. This feature will not be mechanized on the test target.

2.4.6.2 Target Motion. Target motion represented shall be either left or right at an angle of 45° toward or away from the firing line with the target facing in the direction of motion. The following representative target speeds will be tested:

- Target moves 5 or 7.5 m in two sec;
- Target moves 5, 7.5 or 10 m in two sec; and
- Target moves 5, 7.5 or 10 m in four sec.

To initiate a test, the operator will input the range to the lead servo control and program the target speed into the velocity function generator. The operator will then activate the target's simulation motion. The resulting lead displacement of the target frame will be measured with the scale and recorded. This test will be replicated at 25 m increments from 25 m to 200 m. The resulting data will be used to assess the simulation effectiveness of the moving-target lead mechanism.

The breadboard model of the moving-target radiation detector should demonstrate that the target frame is capable of moving at least ± 1.17 m from the central position immediately in front of the 3-dimensional target figure.

The ability of the servo-mechanism to correctly position the array for various values of range from 25 to 200 m and target velocity from 0 to 5 m/sec shall be demonstrated using simulated electrical signal inputs to the servo which represent range and velocity information. Readings shall be obtained under the following simulated conditions:

- Range 25 m - Target velocity 1 and 5 m/sec
- Range 50 m - Target velocity 1 and 5 m/sec
- Range 75 m - Target velocity 1 and 5 m/sec
- Range 100 m - Target velocity 1 and 5 m/sec
- Range 125 m - Target velocity 1 and 5 m/sec

- Range 150 m - Target velocity 1 and 5 m/sec
- Range 175 m - Target velocity 1 and 5 m/sec
- Range 200 m - Target velocity 1 and 5 m/sec

2.4.7 ACCEPTANCE CRITERIA. The breadboard moving-target detector mechanism must correctly position the detector frame to within ± 5% of maximum displacement, or ± 3 cm whichever is greater, for all of the specified target speeds and ranges.

2.4.8 TEST RECORDING. Data for this test element will be recorded on the test record form shown in Figure 14.

2.4.9 TOLERANCE DATA. Table 5 shows the lead, in meters, as a function of firing range for the several target speeds (steady-state) which are required.

2.5 EFFECTIVE SIMULATION OF FIRING WITH SERVICE AMMUNITION AT SCALED RECORD FIRE RANGE

2.5.1 OBJECTIVE. These tests will utilize a special testing target with a matrix of aiming points provided both inside and outside of a superimposed target shape. Matrix aiming points will be where vertical and horizontal lines cross and will be close enough together to establish "hit" and "miss" areas within the required tolerance when the aiming points are "fired" upon successively by the test operator utilizing the breadboard laser transmitter. "Hit" or "miss" will be sensed with hits being indicated on the control unit. The results of each "shot" will be recorded on prepared tables or charts, and the "hit" or "miss" areas plotted on scale targets for submission with the test report. This test will be conducted for each type target specified at the minimum, maximum and intermediate specified ranges.

2.5.2 EQUIPMENT REQUIRED. The following is a list of equipment required to perform this test.

- Scale targets (breadboard CLIN 0003AD);
- Scale target laser radiation detector (breadboard CLIN 0003AD);
- Target control unit (breadboard CLIN 0003AD);
- Laser transmitter (breadboard CLIN 0003);
- Transmitter aperture cap (breadboard CLIN 0003AD);
- Scope sight/laser transmitter adapter; and
- Test target.

TYPE TEST: TARGET LEAD, MOVING TARGET

DATE: _____ TIME _____

TEST NO.	SIMULATED		MEASURED LEAD(M)	PREDICTED LEAD (M)	VARIATION	
	RANGE(M)	SPEED(M/S)			(M)	(%)

TEST CONDUCTED BY: _____

TEST WITNESSED BY: _____

APPROVAL BY: _____

DATE: _____

Figure 14. Test Record Form, Moving Target

Table 5. Lead Distance of Array

FOR A RANGE OF 25 METERS THE PROJECTILE VELOCITY IS 970.67 METERS / SECOND

TARGET VELOCITY (METERS/SEC)	LEAD ANGLE (RADIANS)	LEAD DISTANCE (METERS)
.25	1.82E-04	6.44E-03
.50	3.64E-04	1.29E-02
.75	5.46E-04	1.93E-02
1.00	7.28E-04	2.57E-02
1.25	9.11E-04	3.22E-02
1.50	1.09E-03	3.86E-02
1.75	1.27E-03	4.50E-02
2.00	1.46E-03	5.14E-02
2.25	1.64E-03	5.79E-02
2.50	1.82E-03	6.43E-02
2.75	2.00E-03	7.07E-02
3.00	2.19E-03	7.71E-02
3.25	2.37E-03	8.35E-02
3.50	2.55E-03	8.99E-02
3.75	2.73E-03	9.63E-02
4.00	2.91E-03	1.03E-01
4.25	3.10E-03	1.09E-01
4.50	3.28E-03	1.16E-01
4.75	3.46E-03	1.22E-01
5.00	3.64E-03	1.28E-01

FOR A RANGE OF 50 METERS THE PROJECTILE VELOCITY IS 953.28 METERS / SECOND

TARGET VELOCITY (METERS/SEC)	LEAD ANGLE (RADIANS)	LEAD DISTANCE (METERS)
.25	1.85E-04	1.31E-02
.50	3.71E-04	2.62E-02
.75	5.56E-04	3.93E-02
1.00	7.42E-04	5.24E-02
1.25	9.27E-04	6.55E-02
1.50	1.11E-03	7.86E-02
1.75	1.30E-03	9.17E-02
2.00	1.48E-03	1.05E-01
2.25	1.67E-03	1.18E-01
2.50	1.85E-03	1.31E-01
2.75	2.04E-03	1.44E-01
3.00	2.23E-03	1.57E-01
3.25	2.41E-03	1.70E-01
3.50	2.60E-03	1.83E-01
3.75	2.78E-03	1.96E-01
4.00	2.97E-03	2.09E-01
4.25	3.15E-03	2.22E-01
4.50	3.34E-03	2.35E-01
4.75	3.52E-03	2.48E-01

Table 5. Lead Distance of Array (Cont'd)

FOR A RANGE OF 75 METERS THE PROJECTILE VELOCITY IS 935.93 METERS / SECOND

TARGET VELOCITY (METERS/SEC)	LEAD ANGLE (RADIANS)	LEAD DISTANCE (METERS)
.25	1.89E-04	2.00E-02
.50	3.78E-04	4.01E-02
.75	5.67E-04	6.01E-02
1.00	7.56E-04	8.01E-02
1.25	9.44E-04	1.00E-01
1.50	1.13E-03	1.20E-01
1.75	1.32E-03	1.40E-01
2.00	1.51E-03	1.60E-01
2.25	1.70E-03	1.80E-01
2.50	1.89E-03	2.00E-01
2.75	2.08E-03	2.20E-01
3.00	2.27E-03	2.40E-01
3.25	2.46E-03	2.60E-01
3.50	2.64E-03	2.80E-01
3.75	2.83E-03	3.00E-01
4.00	3.02E-03	3.20E-01
4.25	3.21E-03	3.39E-01
4.50	3.40E-03	3.59E-01
4.75	3.59E-03	3.79E-01
5.00	3.78E-03	3.99E-01

FOR A RANGE OF 100 METERS THE PROJECTILE VELOCITY IS 918.61 METERS / SECOND

TARGET VELOCITY (METERS/SEC)	LEAD ANGLE (RADIANS)	LEAD DISTANCE (METERS)
.25	1.92E-04	2.72E-02
.50	3.85E-04	5.44E-02
.75	5.77E-04	8.16E-02
1.00	7.70E-04	1.09E-01
1.25	9.62E-04	1.36E-01
1.50	1.15E-03	1.63E-01
1.75	1.35E-03	1.90E-01
2.00	1.54E-03	2.17E-01
2.25	1.73E-03	2.45E-01
2.50	1.92E-03	2.72E-01
2.75	2.12E-03	2.99E-01
3.00	2.31E-03	3.26E-01
3.25	2.50E-03	3.53E-01
3.50	2.69E-03	3.80E-01
3.75	2.89E-03	4.07E-01
4.00	3.08E-03	4.34E-01
4.25	3.27E-03	4.61E-01
4.50	3.46E-03	4.88E-01
4.75	3.66E-03	5.15E-01
5.00	3.85E-03	5.42E-01

Table 5. Lead Distance of Array (Cont'd)

FOR A RANGE OF 125 METERS THE PROJECTILE VELOCITY IS 901.30 METERS / SECOND

TARGET VELOCITY (METERS/SEC)	LEAD ANGLE (RADIANS)	LEAD DISTANCE (METERS)
.25	1.96E-04	3.47E-02
.50	3.92E-04	6.93E-02
.75	5.88E-04	1.04E-01
1.00	7.85E-04	1.39E-01
1.25	9.81E-04	1.73E-01
1.50	1.18E-03	2.08E-01
1.75	1.37E-03	2.42E-01
2.00	1.57E-03	2.77E-01
2.25	1.77E-03	3.12E-01
2.50	1.96E-03	3.46E-01
2.75	2.16E-03	3.81E-01
3.00	2.35E-03	4.15E-01
3.25	2.55E-03	4.50E-01
3.50	2.75E-03	4.84E-01
3.75	2.94E-03	5.19E-01
4.00	3.14E-03	5.53E-01
4.25	3.33E-03	5.87E-01
4.50	3.53E-03	6.22E-01
4.75	3.73E-03	6.56E-01
5.00	3.92E-03	6.91E-01

FOR A RANGE OF 150 METERS THE PROJECTILE VELOCITY IS 883.99 METERS / SECOND

TARGET VELOCITY (METERS/SEC)	LEAD ANGLE (RADIANS)	LEAD DISTANCE (METERS)
.25	2.00E-04	4.24E-02
.50	4.00E-04	8.48E-02
.75	6.00E-04	1.27E-01
1.00	8.00E-04	1.70E-01
1.25	1.00E-03	2.12E-01
1.50	1.20E-03	2.54E-01
1.75	1.40E-03	2.97E-01
2.00	1.60E-03	3.39E-01
2.25	1.80E-03	3.81E-01
2.50	2.00E-03	4.23E-01
2.75	2.20E-03	4.66E-01
3.00	2.40E-03	5.08E-01
3.25	2.60E-03	5.50E-01
3.50	2.80E-03	5.92E-01
3.75	3.00E-03	6.34E-01
4.00	3.20E-03	6.77E-01
4.25	3.40E-03	7.19E-01
4.50	3.60E-03	7.61E-01
4.75	3.80E-03	8.03E-01
5.00	4.00E-03	8.45E-01

Table 5. Lead Distance of Array (Cont'd)

FOR A RANGE OF 175 METERS THE PROJECTILE VELOCITY IS 866.66 METERS / SECOND

TARGET VELOCITY (METERS/SEC)	LEAD ANGLE (RADIANS)	LEAD DISTANCE (METERS)
.25	2.04E-04	5.05E-02
.50	4.08E-04	1.01E-01
.75	6.12E-04	1.51E-01
1.00	8.16E-04	2.02E-01
1.25	1.02E-03	2.52E-01
1.50	1.22E-03	3.03E-01
1.75	1.43E-03	3.53E-01
2.00	1.63E-03	4.03E-01
2.25	1.84E-03	4.53E-01
2.50	2.04E-03	5.04E-01
2.75	2.24E-03	5.54E-01
3.00	2.45E-03	6.04E-01
3.25	2.65E-03	6.55E-01
3.50	2.86E-03	7.05E-01
3.75	3.06E-03	7.55E-01
4.00	3.26E-03	8.05E-01
4.25	3.47E-03	8.55E-01
4.50	3.67E-03	9.05E-01
4.75	3.88E-03	9.55E-01
5.00	4.08E-03	1.01E+00

FOR A RANGE OF 200 METERS THE PROJECTILE VELOCITY IS 849.31 METERS / SECOND

TARGET VELOCITY (METERS/SEC)	LEAD ANGLE (RADIANS)	LEAD DISTANCE (METERS)
.25	2.08E-04	5.89E-02
.50	4.16E-04	1.18E-01
.75	6.24E-04	1.77E-01
1.00	8.33E-04	2.35E-01
1.25	1.04E-03	2.94E-01
1.50	1.25E-03	3.53E-01
1.75	1.46E-03	4.11E-01
2.00	1.67E-03	4.70E-01
2.25	1.87E-03	5.29E-01
2.50	2.08E-03	5.87E-01
2.75	2.29E-03	6.46E-01
3.00	2.50E-03	7.05E-01
3.25	2.71E-03	7.63E-01
3.50	2.91E-03	8.22E-01
3.75	3.12E-03	8.80E-01
4.00	3.33E-03	9.39E-01
4.25	3.54E-03	9.97E-01
4.50	3.75E-03	1.06E+00
4.75	3.95E-03	1.11E+00
5.00	4.16E-03	1.17E+00

2.5.3 TEST SET-UP. This test will be performed using the configuration shown in Figure 15.

2.5.4 TEST DURATION. The estimated time required for this test is one day.

2.5.5 DATA REQUIRED. The following data will be required throughout all firings conducted during this test element:

- Range to target;
- Target configuration;
- Location of aim point;
- Number of shots fired;
- Number of recorded target hits;
- Number of false hits recorded;
- Number of proper system responses; and
- Number of failures of system to respond properly.

2.5.6 TEST PROCEDURE. The test target will be mounted with a hinge on the 1/12-scale target assembly. The hinge will allow the test target to be positioned in front of the 1/12-scale target.

The scope sight adapter with the laser transmitter attached will be mounted on a rest capable of adjustment to allow point-of-aim to be positioned on the grid aiming points provided and capable of holding point-of-aim constant after adjustment. The test target will be folded out of the line-of-sight and the laser fired. A hit on the target will be indicated by a hit counter on the control unit panel which is connected to the laser radiation detector output of the 1/12-scale target assembly.

For scaled ranges between 50 and 100 m, the scale target used will be compatible with an F-type silhouette target; for ranges between 150 and 300 m, the scale target will be compatible with an E-type silhouette target.

A set of aiming points will be selected on the test target. These points will lie outside the silhouette target such that laser pulses aimed at these points should not trigger the Hit Indicator. In addition to these aiming points, a second set of aiming points which are within the target silhouette such that laser pulses aimed at these points should trigger the Hit Indicator.

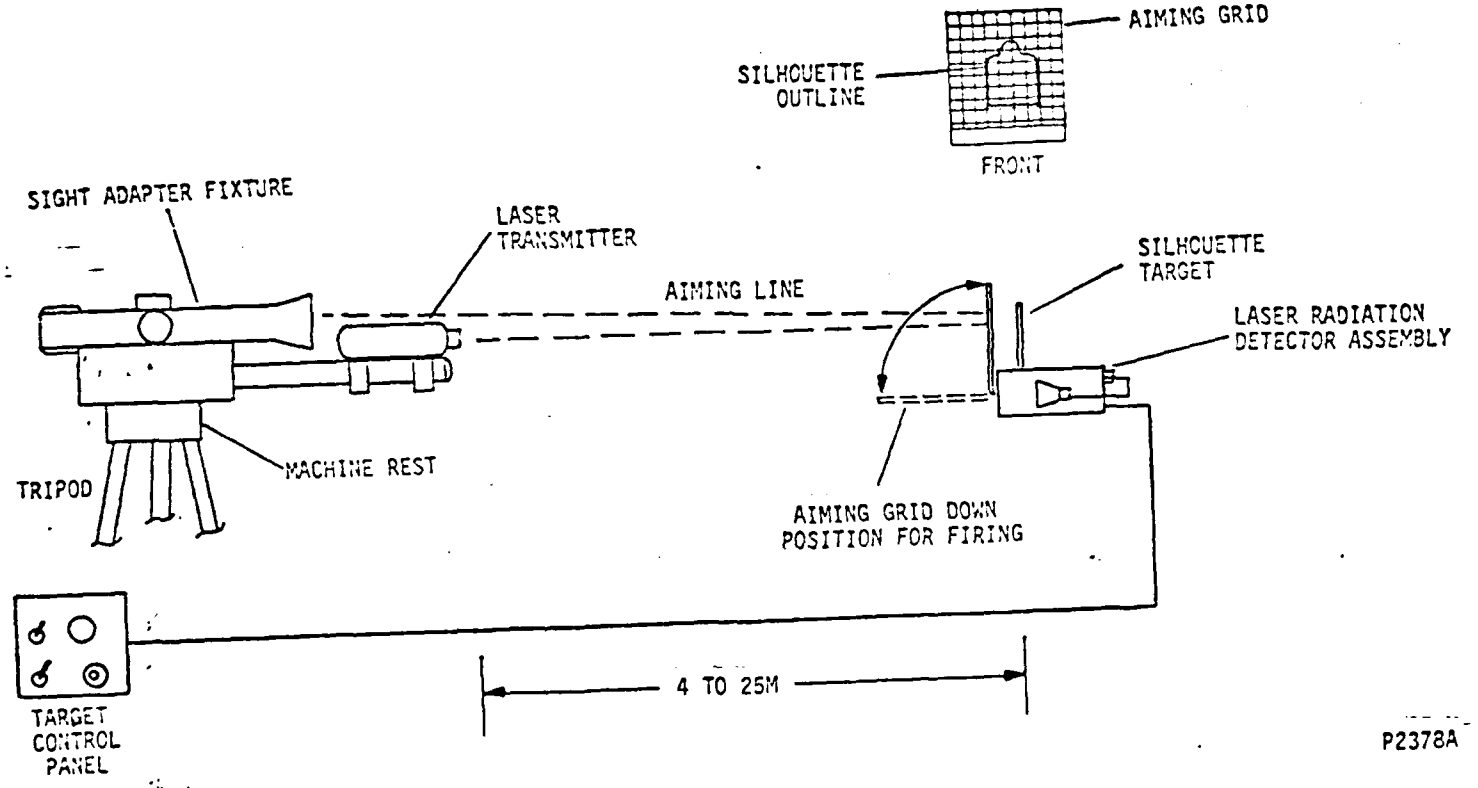


Figure 15. 1/12 Scale Test Target Configuration

At each of the ranges indicated in Table 6, 20 round firings will be conducted using each of the aiming points of the group as indicated.

Table 6. Target Type/Scale Range

Target Range (m)	Target Type
300	E
250	E
200	E
150	E
100	F
50	F

Upon completion of the testing, the ratio of indicated hits to total simulated rounds fired will be calculated for each range of fire at each aim point considered. The relationship between percent correct response range and percent incorrect response range will be determined. Data will be combined to provide best estimates of effective simulation.

2.5.7 ACCEPTANCE CRITERIA. Aim points will be selected both inside and outside the periphery of the targets which are equal to the standard deviation of the M16A1 (0.4 mr 1 σ) or 0.42 cm whichever is largest. These test aim point boundaries result from 1/12 scaling of the boundaries derived for the full scale range.

Selected aim points for the effective simulation demonstration are given in Table 7.

Inside and outside aim point borders are represented on the F and E target test record chart. The acceptable hits or misses are equal to 99% of the total rounds fired at each target range.

2.5.8 TEST RECORDING. The scaled range test target grid is scaled 1/12 (from 6 cm to 0.5 cm) of the full size test target grid. This allows data for this test element to be recorded on the form and charts illustrated for full scale effective simulation (Figures 8, 16 and 17).

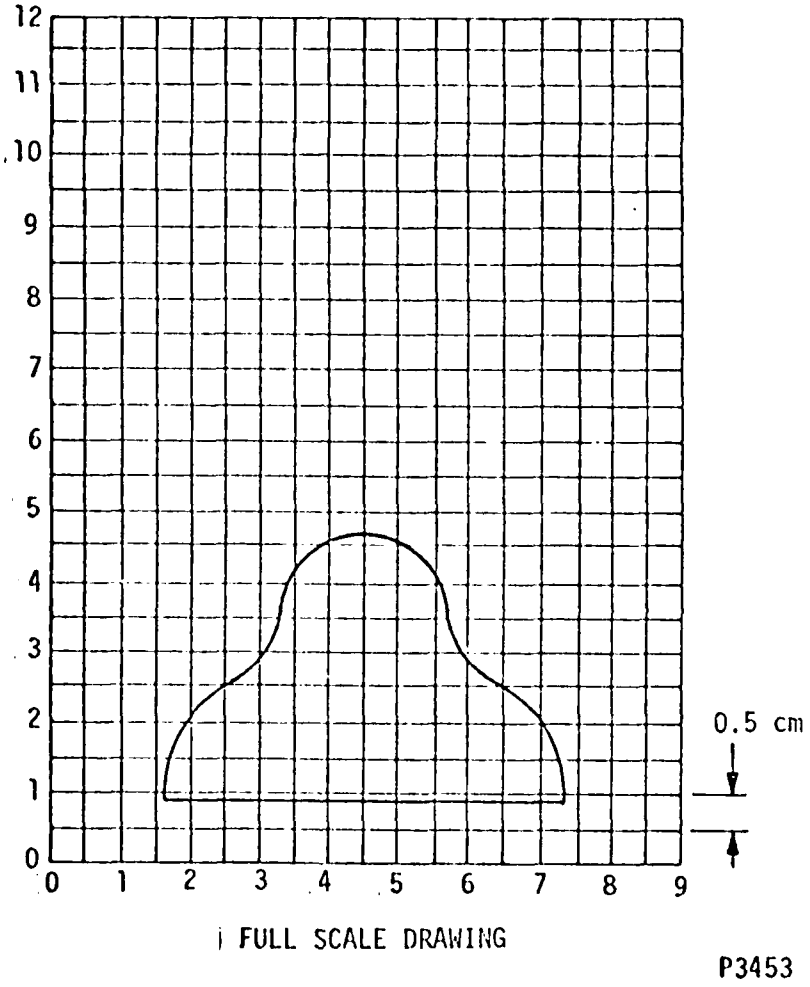


Figure 16. Record Chart, Scaled Record Range (50 and 100 m)

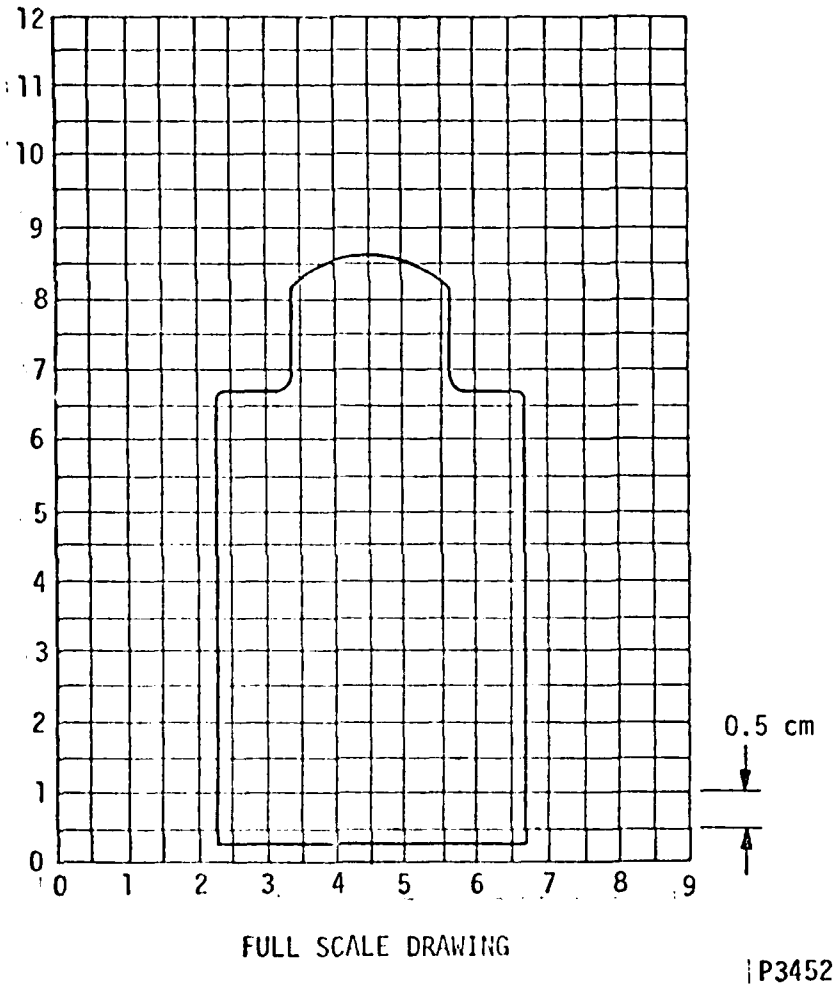


Figure 17. Record Chart, Scaled Record Range (150 to 300 m)

Table 7. Selected Aim Points

Range (m)	Scaled Range (m)	Delta (cm) (0.4 mr 1σ)	Aim Points (cm) Normal to Edge
50	4.17	0.17	± 0.42
100	8.33	0.33	± 0.42
150	12.50	0.50	± 0.50
200	16.67	0.67	± 0.67
250	20.83	0.83	± 0.83
300	25.00	1.00	± 1.00

2.5.9 TOLERANCE DATA. The objective is to obtain scores on a 1/12 scaled range approximating scores that the same rifleman would obtain on full scale targets. For this reason, target dimensions and range dimensions have been reduced to 1/12 of full scale.

APPENDIX A

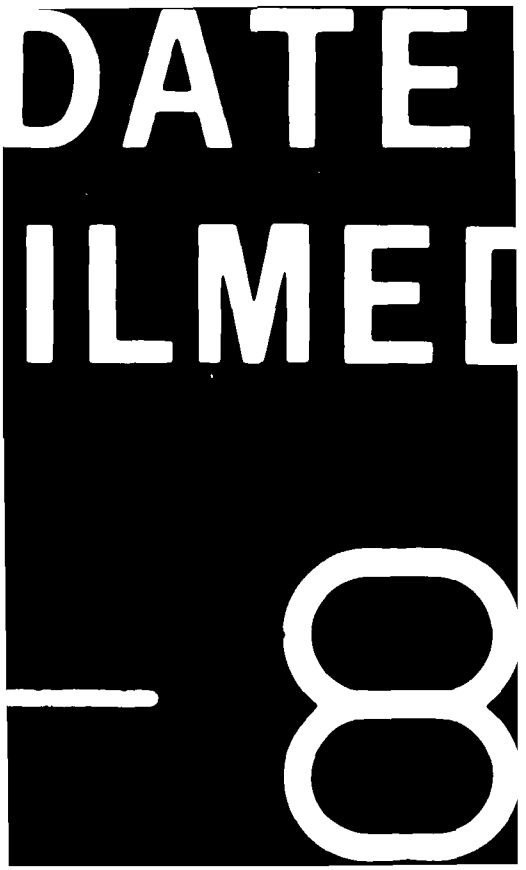
1.0 TURN-ON AND TURN-OFF PROCEDURES OF THE TRAINER

The effective simulation, range and alignment tolerance test will be conducted using breadboard hardware, therefore, detail trainer operating procedures are not appropriate to this document.

2.0 CROSS REFERENCE LISTING OF THE TRAINER SPECIFICATIONS AND THE APPLICABLE TEST THAT APPLIES

Specifications for MAGLAD device A3F77 are given in N2234-129A dated 9 August 1976 and further detailed in Section F of Contract No. N61339-76C-0116. Following is a cross-reference listing from the trainer specification to the applicable test detailed in this document:

TRAINER SPECIFICATION	TEST SECTION
3.2.1.	2.2
3.2.5.1.	2.1
3.2.5.2.	2.1
3.6.1.	2.2
3.6.1.1.	2.2.6.1
3.6.1.2.	2.2.6.1
3.6.1.3.	2.2.6.2
3.6.3.	2.1.7
3.6.9.	2.4
3.6.9.1.	2.4.6.2
3.6.10.1	2.5
3.6.10.1.1	2.5
3.7.4.	2.1.1
3.7.5.2.	2.2.1
4.4.2.2.a	1.0
4.4.2.2.2	2.0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